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AD No. 295065

INTERIM DEVELOPMENT REPORT

FOR

DEVELOPMENT & CONSTRUCTION OF WATER-TIGHT CABLES

RG 11 a/u-RG 217/u-RG 218/u

THIS REPORT COVERS THE PERIOD SEPTEMBER 29, 1962 TO JANUARY 15, 1963

SURPRENANT MFG. CO.

AN ITT SUBSIDIARY

172 STERLING STREET

CLINTON, MASS.

NAVY DEPARTMENT BUREAU OF SHIPS ELECTRONICS DIVISION

CONTRACT No.-NObsr-87574

PROJECT SERIAL NO. SR008-80-302

TASK NO. 9634

JANUARY 28, 1963

$1.60

ABSTRACT

The report herein outlined contains technical and factual data concerning the development of three watertight coaxial cables to be fabricated and tested per specification Ships-C-407. This is the second in a series of your quarterly engineering reports and shows progress covered in the period September 29, 1962 through January 15, 1963. Outlined is the expected progress through the next quarter covered in the period January 16, 1963 through April 5, 1963 and through to termination of contract on June 28, 1963. Explained are testing procedures and equipment used to date, as well as the data obtained. Identified are all personnel assigned to the project to date, their functions and positions in connection to the project. Discussed are the purposes of the research phases and end results obtained and expected pertinent to Specification Ships-C-4017. The technical procedures used and expected to be used to gain satisfactory end results are outlined, as well as all materials and their used in connection with the end product. Results of all tests and experiments are explained as to the reasons for success or failure and the underlying causes and corrective actions taken.

PART I

PURPOSE

1. Fabrication of center conductor

The center conductor to be used in these cables must be fabricated with the following points in mind:

a. Be able to withstand 1000 PSI hydrostatic pressures when applied to the open end of the completed cable.

b. Enable the cable to be as pliable as possible over the applicable temperature range and still maintain excellent hydrostatic and electrical properties.

c. Be fabricated of materials that will afford low electrical loss qualities.

With these various points in mind we are fabricating the RG 217/U cable with both a stranded blocked conductor and a solid conductor. The two constructions will be tested and evaluated for the above points and the most suitable overall conductor will be chosen and installed in all three type cables.

2. Primary Dielectric

The material to be used in this operation must have the properties to enable it to pass all physical and electrical tests pertinent to the specification. It must also possess the quality of allowing the completed cable to remain as small and lightweight as is commensurate with all test.

3. Application of Outer Conductor

The outer conductor of all cables shall be comprised of either a single or double metallic braid suitably sealed with an appropriate material to withstand the hydrostatic and low temperature bend tests. The outer conductor shall be applied in such a manner that all physical and electrical tests called out in the pertinent specification shall be complied with.

4. Overall Outer Jacket

The outer jacket must be applied in such a manner that a tight bond occurs between it and the outer perimeter of the cable beneath. The material must be such that all hydrostatic and physical tests be complied with. The construction must use a material such that a bond can be obtained between the outer jacket and polyurethane with little trouble.

GENERAL FACTUAL DATA

(A) Identification of Technicians

1. Donald Alexander - Vice-President-Engineering

   Man hours work performed September 29, 1962 to January 15, 1963

2. Richard McKinstry - Project Engineer

   Man hours work performed September 29, 1962 to January 15, 1963

3. E. W. Bennett - Chemical Engineer

   Man hours work performed September 29, 1962 to January 15, 1963

4. John Gamblin - R&D Laboratory Technician

   Man hours work performed September 29, 1962 to January 15, 1963

5. William Waslaske - R&D Laboratory Technician

   Man hours work performed September 29, 1962 to January 15, 1963

(B) References

None

(C) Formulae

Calculated impedance and size formulae used in cables.

1. Capacitance = $\frac{(K)(7.36)}{\log_{10} D/d}$

2. Impedance Z_o = $\frac{10600}{\underset{\text{MMF/ft.}}{(\text{Capacitance})}\underset{\%}{(\text{Velocity})}}$

3. Attenuation = $\frac{1}{1.46}\ 20 \log_{10} \frac{M1}{M2}$

4. Outer Conductor braid angle and percent coverage

   Percent coverage = $(2F-F^2)100$

   Where: $F = \frac{NPd}{\sin \angle a}$; $\tan \angle a = \frac{2\pi (D+2d)P}{C}$

Formulae derived from MIL-C-17 latest issue

Capacitance - Paragraph 4.6.7

Velocity - Paragraph 4.6.12.1

Impedance - Paragraph 4.6.12

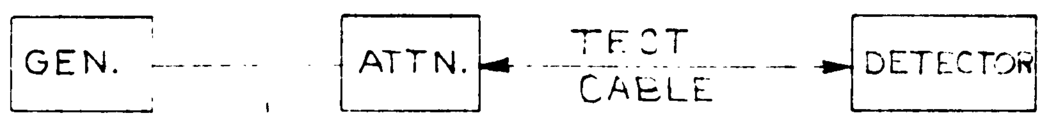
Attenuation - Paragraph 4.6.10

(D) Illustrations

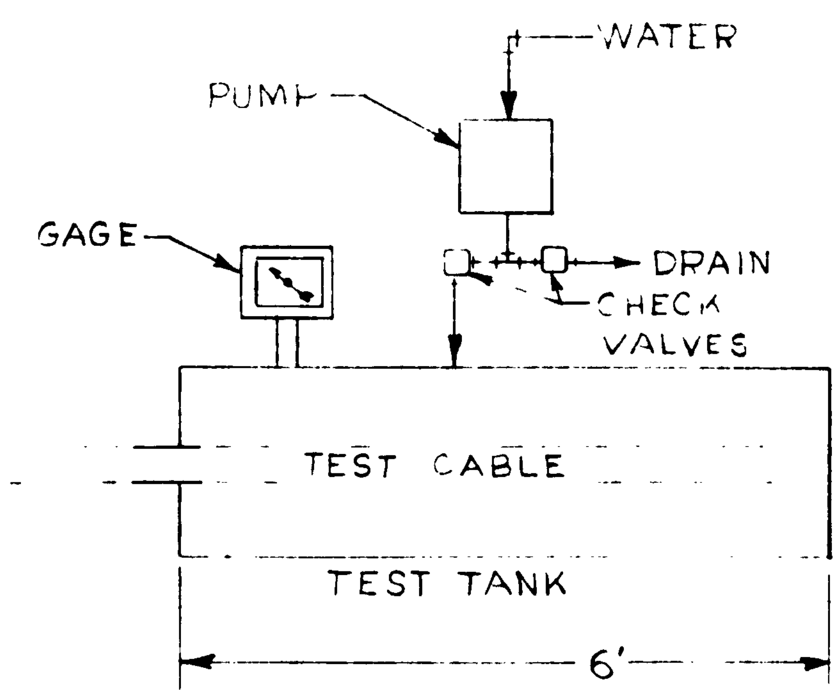
None

(E) Measurement Procedures

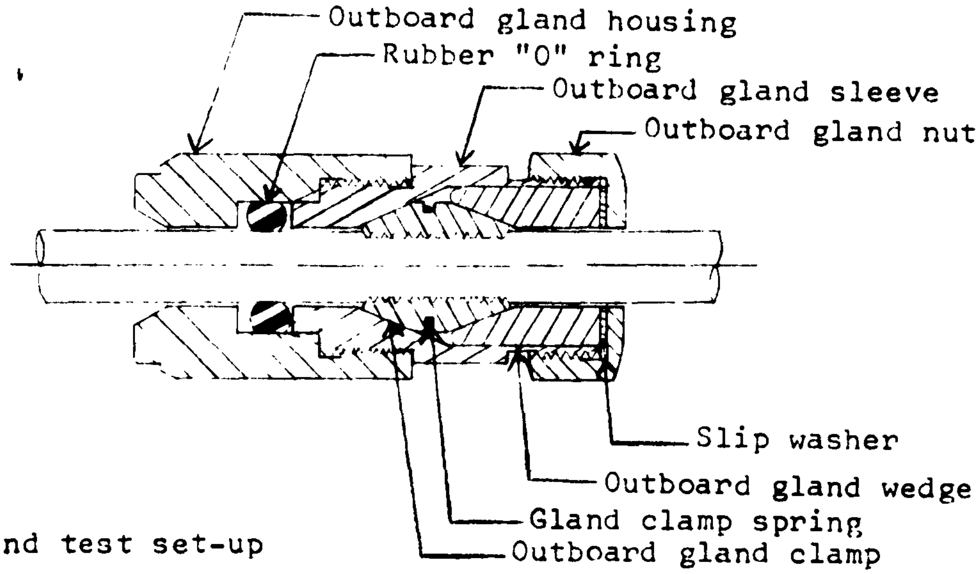
1. Attenuation test setup (Substitution method)



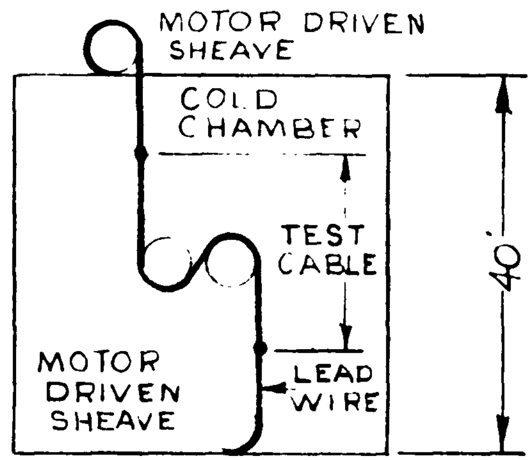
2. Hydrostatic test set-up



3. Non-restrictive gland assembly used for hydrostatic tests.



4. Cold bend test set-up



5. Instrument tabulation

a. Capacitance bridge - General Radio Co. - Type 716-C

b. Oscilloscope Detector - A.B. Dumont Co.-Cathode Ray Type 304-A.

c. Q-Meter-Boonton Radio Corp. - Type 170-A

d. Attenuation -

Signal Generator-Hewlett Packard Co.-Model 608-C

Radar Receiver - R 54/Apr-4

Tuning Unit - TN-18/APR-4-Range 300 to 1000 M.C.

Tuning Unit-TN-19/Apr-4-Range 975 to 2200 M.C.

Tuning Unit-TN-54/Apr-4-Range 2150 to 4000 M.C.

e. High Voltage Testing Set-General Electric Co.-Type K

f. Hydrostatic Test Pump-Henderen Co.-No. 30

DETAIL FACTUAL DATA

In one initial run of RG 11 A/U cable a stranded, blocked conductor was used. The conductor consisted of bare copper strands and employed a General Electric Co. #SS-4004 strand priming agent and RTV-60 silicone blocking material. This proved successful in hydrostatic pressure tests but a slight oxidation was the bare copper was noticed due to the excessive heats employed in the extrusion of the primary compound. It was decided at this time that a silver plating on the copper would reduce this condition and also afford a better opportunity of lowering the attenuation readings. A control sample using the silver plated copper stranding was fabricated for the RG 11 A/U and RG 217/U cables employing the same materials mentioned above. This proved unsuccessful due to some undefined reaction between the silver plating, the primary agent and the RTV-60 silicone compound. After curing this fabricated conductor, there would be no bond between the conductor and the blocking compound. A program using several blocking compounds and primary agents is now under way to overcome this problem. Meanwhile, control samples using a solid silver plated conductor for the RG 217/U and RG 218/U cable are now being manufactured. A problem in the silver plating of the larger .195 O.D. RG 218/U conductor was encountered. The plating line used for the silver plating of wire here at the plant was not large enough in capacity to accommodate this large plating surface. We found when we started to plate this wire the plating was spotty and would tend to flake off when the wire was flexed. This was overcome by increasing the current in the plating tank and building a special slow speed take-up to increase the immersion time of the wire in the plating tank.

Under construction at the present time are control samples of RG 217/U utilizing both stranded and solid conductors. These samples will then be subjected to the hydrostatic, cold bend, attenuation and especially the pliability tests to determine the advantages or disadvantages of one type conductor over the other. With the data thus far obtained it is felt the advantage of a solid type conductor would be: 1. Hydrostatic quality would be of a higher and steadier nature 2. The attenuation would be somewhat lower 3. The ease of connector installation due to the lack of blocking material on and in the conductor.

The advantages of a stranded type conductor would be 1. The overall cable pliability over the specified temperature range.

In our attempts to apply a solid FEP Teflon primary extrusion over the solid conductor in the RG 217/U and RG 218/U we have experienced very good success as far as the test program has proceeded. A control sample of RG 217/U has been successfully completed to the point of application of the final jacket. The construction and test results and procedures to date are as follows:

Core Construction:

Conductor - Solid silver plated copper - O.D. - .106

Primary - Extruded FEP Teflon - O.D. - .310

This core was then tested for the following:

Hydrostatic Test: A 5 ft. length of cable was inserted in the before mentioned test set-up using the non-restrictive gland assembly with 4 ft. inside the pressure tank and 1 ft. outside. A pressure of 1000 psi was applied to the open end of this cable for a period of 2 hours. No leakage occurred. This specimen was then taken up to a test pressure of 2000 psi in increments of 200 psi for a period of 1 hour at each. At the end of this time there was still "0" leakage. A sample of this control run was then subjected to the cold bend test in the manner shown in the preceding diagram. The test was given at a temperature of -60°C and immediately afterward given a hydrostatic test of 2000 psi for 2 hours. No leakage occurred.

An outer conductor of metallic brand was then applied to this same core and the capacitance and velocity were measured and impedance calculated with the following results:

Capacitance - 29.55 MMF/ft.

Velocity - 70.5%

Impedance - 49.5ohms

A dielectric breakdown test was then performed by immersing the sample in a tank and using water as ground. The following occurred:

A dielectric strength of 12000 volts RMS was applied for 3 minutes with no breakdown. Voltage was then increased to 36,700 volts RMS until breakdown occurred.

The first shield was then applied over this core consisting of 7 ends of #33 AWG bare copper, 24 carriers, 9 picks/inch giving a flat angle braid of 37.4° with 93% coverage. The flat angle of the shield will aid in the flexibility of the cable. This shield was sealed with Anaconda I-5906 Superseal and a binder of .002 X 1" FEP Teflon tape was tightly wrapped overall with a 50% lap. The second shield was applied over this in the same manner. This shield consisted of 7 ends of #33 AWG bare copper, 24 carriers, 10 picks/inch giving a 43.5° Angle and 92.3% coverage. There is some question as to whether this second shield is necessary or will only detract from the pliability. Control samples are now under way employing both a single and double shielded construction. Tests will be performed and the data evaluated to determine the best all around construction in this phase. A binder of .005 X 1" FEP Teflon tape will be tightly wrapped over this outer shield with a 50% lap. This is a heat sealable tape and will afford an excellent water barrier under the jacket. Applied over this barrier type tape will be another tape wrapped in opposite direction with 50% lap, this outer tape will be mylar with a backing material which will form a bond between it and the extruded outer jacket. The outer core will come to a maximum O.D. of .400 and much smaller if it is determined that a single shield will suffice. To date this is where we stand on the RG 217/U cable.

The same general construction and test procedures are being followed for the RG 218/U with the following results:

Construction:

Conductor - Solid Silver Plated Copper - O.D. - .195

Primary - Extruded FEP Teflon - O.D. - .585

The hydrostatic, cold bend and electrical tests were performed in the same manner as described for the RG 217/U cable with the following results:

Capacitance - 29.40 MMF/ft.

Velocity - 69.8%

Impedance - 49.5 ohms

Hydrostatic pressure tests showed "0" leakage after completing cold bend and the 1000 PSI to 2000 PSI cycle described earlier.

Dielectric strength tests were performed at 22000 volts RMS in water for 3 minutes and taken to breakdown which occurred at 49,600 volts RMS.

In process now is the application of the shields and blocking to the RG 218/U cable core. Here again it will be determined whether a single or double shield is desirable. We expect that with a double shield application the O.D. under the jacket will come to .700 maximum, and considerably smaller with single shield.

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PROJECT PERFORMANCE AND SCHEDULE CHART

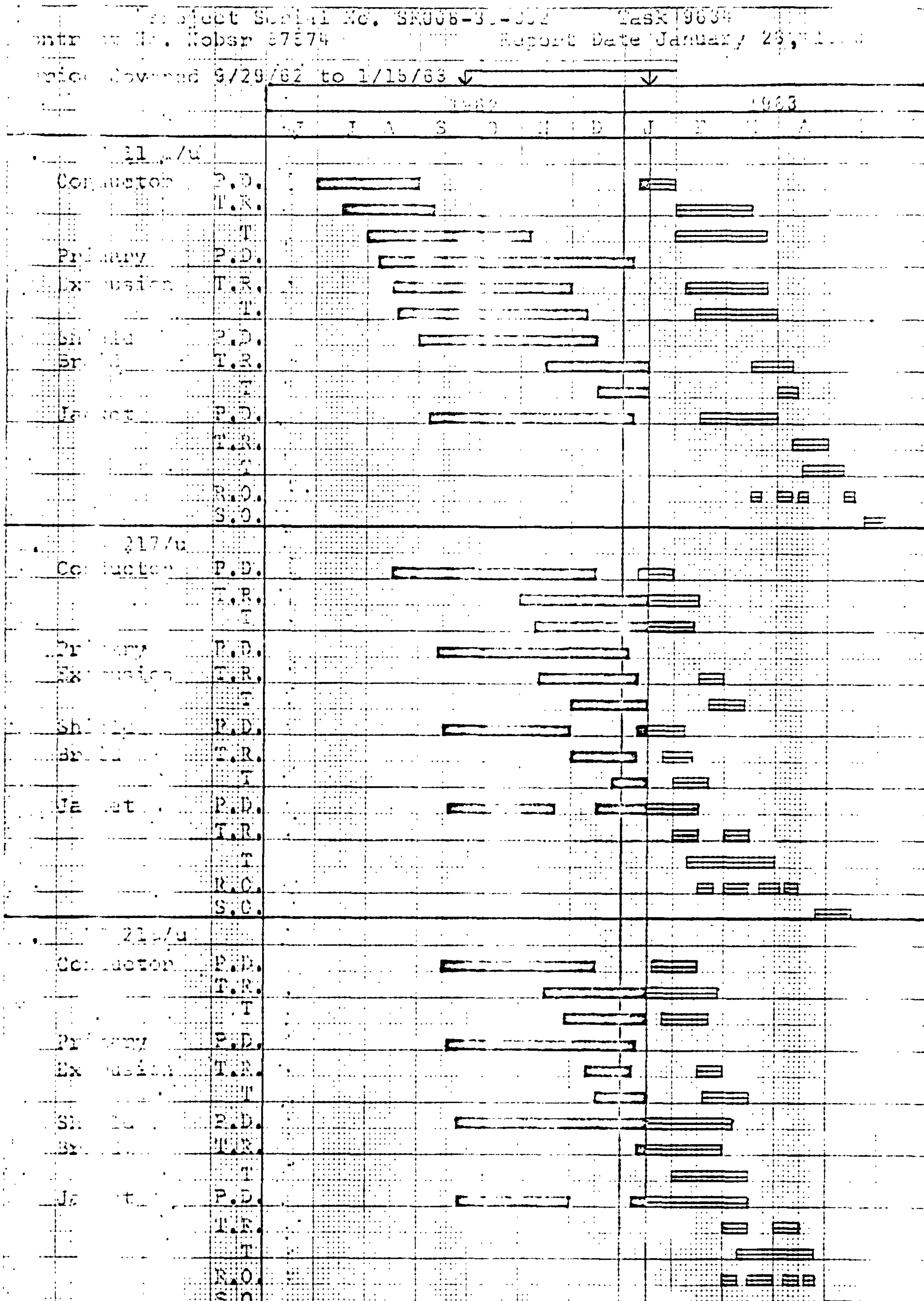

Fig. I - Project Performance and Schedule Chart

ITT Surprenant Mfg. Co.

Project Performance and Schedule Chart

Project Serial No. SR008-80-302 Task No. 9634

Contract No. Nobsr-87574 Report Date - January

Period covered September 29, 1962 to January 15, 1963

Legend:

= Work performed

= Schedule of projected operations

P.D. = Preliminary Design

T.R. = Test Run

T = Test

R.O. = Run Order

S.O. = Submit Order

Item: Estimated completion in percent of total effort to be expended

(not chronological)

	RG 11A/U		RG217/U			
1.	Conductor	100%	Conductor	70%	Conductor	45%
2.	Primary Dielectric	70%	Primary Dielectric	60%	Primary Dielectric	50%
3.	Shielding	70%	Shielding	70%	Shielding	50%
4.	Jacketing	20%	Jacketing	20%	Jacketing	20%
5.	Testing	35%	Testing	25%	Testing	25%
6.	Run 2000' order	0%	Run 2000' order	0%	Run 2000' order	0%

CONCLUSION

In summarization of the Detail Factual Data section of this report there are two types of conductors are under investigation: (a) solid silver plated copper and (b) stranded and blocked silver plated copper. The reason for trying the two types are to arrive at the most flexible cable and still maintain all other physical and electrical aspects of the pertinent specification. Some difficulty is being experienced in the blocking of the stranded silver plated conductor due to the change from bare copper to silver plated copper. We feel that this is a fairly minor problem and can be resolved in relatively short time.

Although we have not given up entirely on the idea of using foamed FEP Teflon as a primary dielectric material, we have found that the solid FEP Teflon ~~has given us~~ gave very good results as a primary dielectric material, and, in the interest of time we are going ahead with this construction in order to have these cables completed by the contract termination date.

In the application of the outer conductor, various tests will be performed to ascertain whether one or two shields are desirous. The blocking and application procedures will not be affected whichever construction is used. Size and weight however are obviously involved.

The outer jacketing material of the cables is limited per paragraph 3.3.1 of Specification Ships-C-4017 which states that the jacket material must be such that a suitable bond can be made with polyurethane without pretreatment of the outer jacket. The two materials under consideration ~~in this case would be of an~~ as jacket material are Estane ~~or~~ and Neoprene types. These two types will be applied and evaluated as to which is best suitable.

PART II

PROGRAM FOR NEXT INTERVAL

What we hope to accomplish before the next quarterly Engineering Report of April 5, 1963 is outlined as follows:

1. Fabricate a stranded silver plated copper conductor and extrude a solid FEP primary dielectric over it for RG 217/U cable. Test and evaluate data obtained as to which is most suitable both physically and electrically for use in the three cables.
2. Attempt to extrude foamed FEP Teflon using a solid conductor in the RG 217/U cable. Test and evaluate the use of this material if successfully extruded.
3. Apply and evaluate the best jacket material for all around use in the three types of cables.
4. Ascertain which is most suitable from a physical and electrical standpoint, a single or double shielded construction for these cables.
5. Complete all testing, physical and electrical, on control samples and draw up specification sheets obtaining all data to be submitted for approval.
6. Start the 2000 ft. order of the three cables using the most suitable constructions according to the test data obtained.